

1 What is claimed is:

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3 1. A method of manufacturing a cylinder liner blank for an internal combustion engine including
4 a cylinder block having at least one cylinder bore, the method comprising the steps of:

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6 providing a cylindrical tube of predetermined dimensions which is formed from a carbon alloy steel
7 starting material;

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9 placing the cylindrical tube into a hydraulic press and cold forging the cylindrical tube into a cylinder
10 liner blank, the cylinder liner blank comprising a liner body with cylindrical sidewalls which define
11 an internal diameter, an external diameter, a cylindrical lower extent and an upper flanged region
12 which is integrally formed in the cold forging process.

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14 2. The method of claim 1, wherein the flanged region of the cylinder liner blank extends radially
15 outwardly relative to the external diameter of the cylindrical sidewalls of the cylinder body so as to
16 define a stop shoulder, the stop shoulder being cooperatively received in abutting relation to a mating
17 surface defined by the cylinder bore of the internal combustion engine.

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19 3. The method of claim 3, wherein the cylinder liner blank is formed from a carbon alloy steel
20 having a carbon content of at least about 0.25%.

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22 4. The method of claim 3, wherein the cylinder liner blank is formed from a carbon alloy steel
23 having a carbon content of at least about 0.50%.

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25 5. The method of claim 3, wherein the cylinder liner blank is formed from a 1055 carbon alloy steel.

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27 6. The method of claim 3, wherein the cylinder liner blank has an internal diameter in the range from
28 about 3 to 8 inches.

1 7. A method of manufacturing a cylinder liner for a diesel engine including a cylinder block having
2 at least one cylinder bore, the method comprising the steps of:

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4 providing a cylindrical tube which is formed from a carbon alloy steel starting material and
5 dimensioning the cylindrical tube to form an unforged cylinder liner blank of predetermined starting
6 dimensions;

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8 placing the unforged cylinder liner blank into a hydraulic press, the hydraulic press having a forging
9 die set with a die cavity for receiving the unforged cylinder liner blank and an upper, flange cavity
10 of greater relative diameter than the die cavity;

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12 closely fitting a forming mandrel within the internal diameter of the cylinder liner blank within the
13 forging die set;

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15 applying a hydraulic force to the cylinder liner blank in the forging die set to thereby cold form an
16 integral flanged region on the cylindrical sidewalls of the cylinder liner blank at an upper extent
17 thereof; and

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19 finish machining the forged cylinder liner blank to form a cylinder liner.

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21 8. The method of claim 6, wherein the flanged region of the cylinder liner extends radially outwardly
22 relative to the external diameter of the cylindrical sidewalls of the cylinder body so as to define a
23 stop shoulder, the stop shoulder being cooperatively received in abutting relation to a mating surface
24 defined by the cylinder bore of the internal combustion engine.

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26 9. The method of claim 7, wherein the cylinder liner blank is formed from a carbon alloy steel
27 having a carbon content of at least about 0.25%.

1 10. The method of claim 7, wherein the cylinder liner blank is formed from a carbon alloy steel
2 having a carbon content of at least about 0.50%.

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4 11. The method of claim 7, wherein the cylinder liner blank is formed from a 1055 carbon alloy
5 steel.

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7 12. The method of claim 7, wherein the cold forging step includes applying 500 to 1,000 tons of
8 hydraulic force to the cylinder liner blank to cause the carbon alloy steel to flow into the flange
9 cavity to form the flanged region of the cylinder body.

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11 13. The method of claim 7, wherein the upper extent of the cylinder liner blank is heated with
12 induction heating in the range of about 1200°F to reduce stress during the cold forging process and
13 enable an increased production life for the hydraulic die set and forming mandrel.

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15 14. A method of assembling an internal combustion engine having a cylinder block and at least one
16 cylinder bore, the method comprising the steps of:

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18 locating a cylinder liner in a concentrically disposed location within the cylinder bore and secured
19 to the cylinder block, the cylinder liner being prepared in a manufacturing process by:

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21 providing a cylindrical tube formed from carbon alloy steel of predetermined starting dimensions;

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23 dimensioning the cylindrical tube to form an unforged cylinder liner blank;

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25 placing the cylinder liner blank into a hydraulic press and cold forming the cylinder liner blank into
26 a forged cylinder liner blank, the forged cylinder liner blank comprising a liner body with cylindrical
27 sidewalls which define an internal diameter, an external diameter, a cylindrical lower extent and an
28 upper flanged or upset region which is integrally formed in the cold forging process;

1 finish machining the forged cylinder liner blank to form a finished cylinder liner; and

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3 wherein the flanged region of the finished cylinder liner extends radially outwardly relative to the
4 external diameter of the cylindrical sidewalls of the cylinder body so as to define a stop shoulder,
5 the stop shoulder being cooperatively received in abutting relation to a mating shoulder defined by
6 the cylinder bore of the internal combustion engine.

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8 15. The method of claim 14, wherein the internal combustion engine is a diesel engine and wherein
9 the cylinder body has an internal diameter in the range from about 3 to 8 inches.

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11 16. The method of claim 14, wherein the cylinder liner blank is a carbon alloy steel having a carbon
12 content of at least about 0.50%.

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14 17. The method of claim 16, wherein the cylinder liner blank is formed of 1055 carbon alloy steel.